CONTRIBUTIONS FROM THE PHYSICAL LABORATORY OF THE ASSACHUSETTS INSTITUTE OF TECHNOLOGY.

L. — AN APPARATUS FOR RECORDING ALTERNATING CURRENT WAVES.

By Frank A. Laws.

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The apparatus forming the subject of this communication was constructed at the Rogers Laboratory in 1898, and has proved of sufficient value to merit a short description. In brief, the arrangement gives us a modification of the "contact method," by which the record is rendered continuous and traced photographically.

The necessary electrical connections are shown in the diagram. K_1 and K_2 are two rigidly connected contact wheels of ebonite. Into the periphery of each wheel are set four brass blocks. These are accurately placed 90° apart. Upon each wheel a brush and collector ring give permanent contact with the blocks. Another brush resting on the periphery of the wheel completes electrical connection as the blocks pass under it. The brushes are so placed that contact is made and broken at K_2 before K_1 closes. The contact wheels are driven by a synchronous motor, which gives one revolution for four complete alternations of the E.M.F. G is a dead-beat galvanometer, and C is an adjustable condenser. The leads *a* and *b* are carried to the points between which the P.D. is to be investigated. By inspection of the diagram it will be seen that once on each wave and at a definite point the condenser C is charged to the potential existing between *a* and *b*. As the charge is determined by the breaking of the contact, the blocks may be of sufficient width to eliminate the effect of the jumping of the brushes. Also the resistance at the contact will not be of sufficient magnitude to prevent complete charging of the condenser.

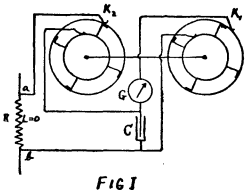

FIG I

The function of K_1 is to discharge the condenser through the galvanometer after K_2 has broken circuit. The instrument would ordinarily experience a constant deflection, but K_1 and K_2 are rigidly connected and mounted on a radial arm, which is geared to the shaft so that it moves very slowly. The effect is to gradually move the contact point over the wave. The deflection of the galvanometer will at any instant be proportional to the P.D. between a and b at the instant of breaking at K_2, or in other words, the deflection follows the wave form.

The actual arrangement is shown in Figure 2 (see Plate), where the contact device, the synchronous motor, and the direct current motor used for starting the apparatus will be seen. By use of worm gearing the wheel train necessary for moving the brushes is made very compact; the reduction for the instrument shown is 7200 to 1.

I have found Sullivan's Universal Galvanometer to be a most satisfactory instrument for use with the apparatus. This galvanometer, of the D'Arsonval type, has a carefully balanced coil, so that it is not very susceptible to mechanical disturbances; also the magnetic damping is most carefully adjusted. The instrument is not of great sensitiveness, but owing to the stiff suspension the zero is perfectly definite.

The camera used for recording the curves is shown in Figure 3 (see Plate). The plate is contained in an ordinary plate holder. This is moved vertically by a fine wire which is wound on a drum, seen in Figure 2, just in front of the lower worm-wheel. This drum can be thrown in at pleasure by a pin clutch. The slide of the plate holder is held stationary by a pin, so that the plate is exposed as the holder is drawn up.

The front of the camera, shown removed, is provided with a narrow slit about $\frac{1}{100}$ of an inch wide. In front of it are projecting lips 9 inches long and $\frac{1}{8}$ of an inch apart. They are blackened within and serve effectually to shut out extraneous light, and thus prevent fogging of the plate. The spot of light used was the sharply focussed image of the filament of an incandescent lamp. An alternative arrangement is to use a plate of ground glass in the holder, and to have a straight-edge fastened across the guides. It is then easy to keep the point of a pencil in contact with it and upon the spot of light.

The arrangement described is of course a device for obtaining the average wave, and unsuitable for recording transient phenomena. The time taken in recording a wave at 120 cycles per second is about $1\frac{1}{2}$ minutes.

The adjustable condenser allows one to adapt the apparatus to varying conditions, so the E.M.F. curves may be taken directly, and the

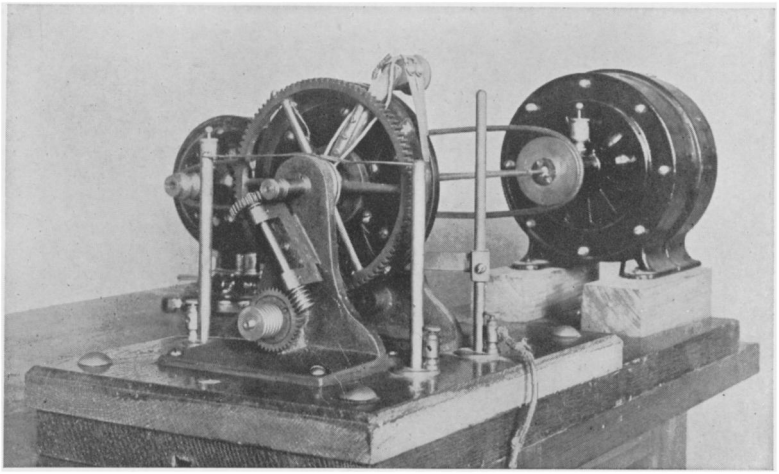

Figure 2.

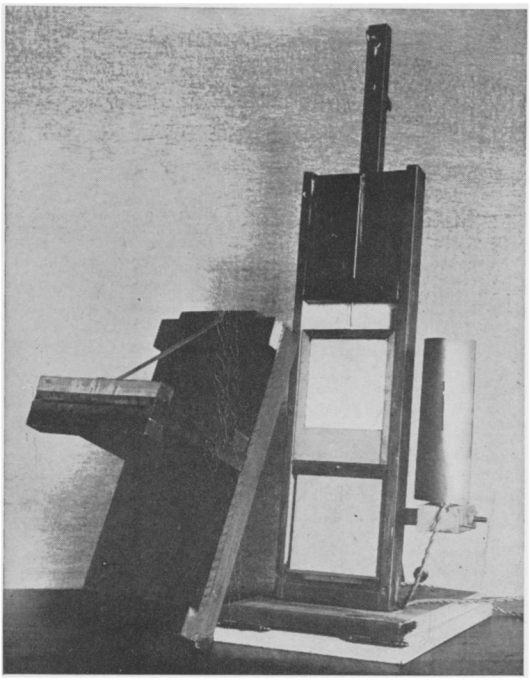

Figure 3.

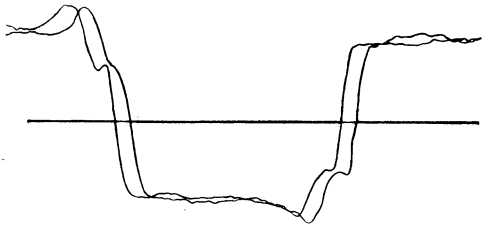

FIGURE 4. — Potential difference between the carbons of an enclosed arc, in series with reactive coil.

The curves were taken about one minute apart with a view to testing the concordance of the readings.

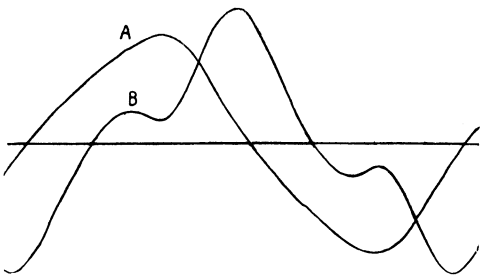

FIGURE 5. — *A*, potential difference between the terminals of a small alternating current motor. *B*, current through motor.

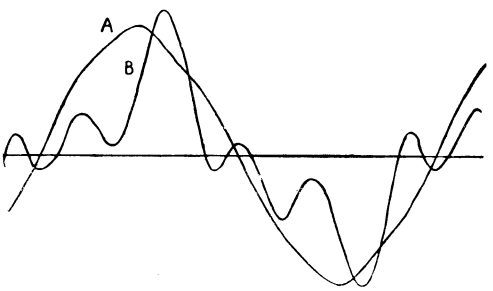

FIGURE 6. — Curve *A* is E.M.F., and *B* is current in one phase of a quarter-phase synchronous motor running idle with the field adjusted for minimum current. Source of power was a three-phase dynamo with phasing transformers arranged on the Scott system.

current curves by the use of a drop wire, as indicated in Figure 1. In starting the arrangement it is very easy to determine when the proper

speed for synchronism has been attained by watching the spot of light, or by listening to a telephone which is inserted in place of the galvanometer. With the latter one hears slow beats as the contact moves over the wave. Opposite are given some examples of the records obtained with the device.

ROGERS LABORATORY OF PHYSICS,
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